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considered as "exaggerated ganglionic swellings" which probably do not represent appendages. Nelson has found nothing which could be "safely construed as abdominal appendages". Degenerating cells of unknown significance occur in the rudiments of the brain, particularly in the region between the second and third lobes of the protocerebrum. The tracheal system is formed from eleven pairs of invaginations of the lateral ectoderm, one pair, which seems to be observed for the first time, occurring on the second maxillary segment. This discovery is significant since "Now that a pair of tracheal sacs is known to exist in the second maxillary segment, the homology of the second pair of tentorial invaginations with the stigmata of the second maxillary segment is completely excluded, and the homology of similar invaginations with those of the trachea is decidedly problematical". The tentorium develops from two pairs of ectodermal invaginations, one in front of the bases of the mandibles and the other behind the bases of the first maxillæ. The œnocytes develop from the migration of cells from eight pairs of localized areas of the lateral ectoderm which occur on the first eight abdominal segments at the same level as the tracheal invaginations. The mesoderm differentiates laterally into a somatic and a splanchnic layer, the mid-ventral region remaining single layered. Separate cœlomic sacs are wanting. The single layered area develops into the rounded blood cells; the somatic layer forms the trunk muscles, the pericardial fat cells, and the dorsal diaphragm; and the splanchnic layer gives rise to the muscle layer of the mid-intestine and the two main divisions of the fat body. A mid-dorsal union of two rows of cardioblasts, derived from the two mesodermal layers, forms the heart. Two masses of mesodermal cells, one forming the anterior and one the posterior end of the mesoderm, produce the muscle layer of the stomodæum and the proctodæum respectively. One hundred fifty-seven titles are included in the bibliography at the end of the book.

Kansas State Agricultural College. PAUL S. WELCH.

NOTES ON OLIGOCHÆTA

Galvanic Response of Earthworm.—Moore and Kellogg ('16, Biol. Bull., 30:131-134) have tested the galvanic reaction of

Lumbricus terrestris to constant current. Orientation began as soon as the current was submitted and the body of the animal took the form of a U with the concave side toward the kathode. Writhing movements accompanied this orientation and as a rule the animal ultimately crawled to the kathode. Pieces of the body of the worm, 3-4 cm. long, subjected to the constant current, responded in the same way, except that progressive movements were absent. Reversal of the current produced a reversal of the response. The reactions are interpreted as due to the tension of the longitudinal muscles on the kathode side of the worm, resulting in a stronger contraction than that which occurs in the anodal region.

South Indian Oligochæta.—Stephenson ('15, Memoirs of the Indian Museum, 6:35-108) reports results of studies on Oligochæta of Ceylon and Southern India. The eversible pharynx of certain enchytræids was studied and a sensory function is suggested for this organ. The constant presence of setæ within the cœlom of *Fridericia carmicheali,* surrounded by masses of lymphocytes, is discussed and the tentative explanation is that they are formed, not as are the setæ of the body-wall, but as excretory products which take the form of rods or spicules, persisting in the body-cavity or disintegrating and being eliminated through the usual channels. The so-called iridescent sperm funnels of some earthworms have been found to be due, not to iridescence of the funnel itself, but to the spermatozoa which are so disposed that they form innumerable extremely fine threads lying parallel and which function as a "diffraction grating". New species of the genera *Enchytræus, Fridericia, Drawida, Pontodrilus, Megascolides, Comarodrilus, Perionyx, Megascolex,* and *Erythræodrilus* are described.

Regeneration.—Hyman ('16, Journ. Exp. Zool., 20:99-163) has studied regeneration in a number of species of Oligochæta belonging to the families *Aeolosomatidæ, Naididæ, Lumbriculidæ,* and *Tubificidæ.* By the use of Child's cyanide method, a gradient in the rate of metabolism of two forms, primary and secondary, was demonstrated. In the former, the rate of metabolism decreases posteriorly from the head and was found only in *Aeolosoma* and the zooids of *Naididæ,* while the latter is superimposed upon the primary gradient but runs in the reverse direction. The secondary gradient involves the caudal third of the body in *Dero limosa,* the caudal half or more in *Lumbriculus inconstans,* and all but the first 5-15 somites in the *Tubificidæ.* Only the typical number of head somites are regenerated following amputation of varying numbers of anterior somites. The head regenerates a tail only when accompanied by a certain number of trunk somites and the tail regenerates a head only when it is of a certain minimum size whereby the gradient is eliminated. Under these conditions, regardless of length, a piece of *Dero limosa* regenerates a normal worm. If of appropriate length, any part of the body of *Lumbriculus inconstans* regenerates a normal worm, normal posterior regeneration occurring at any level. Formation of the head in *Tubifex* ceases at about the level of the fifteenth somite, while in *Limnodrilus* it ceases at the level of the seventh somite. The gradient of an axial series of pieces is not the same as that of the whole worm since temporary stimulation results from the cutting. Rate of metabolism is an important factor in anterior regeneration in short pieces since head formation will be inhibited in proportion to the metabolic rate of the old piece. If this rate be low, no inhibition of the new tissue occurs and a normal head is produced. Normal heads are always formed on long pieces since the dynamic factors are not important and the primary gradient determines the increased independence of cells at an anterior level over those of a more posterior level.

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NOTES ON THE COLLECTION AND REARING OF VOLVOX

Since the rearing of Volvox for laboratory use seems to be more or less unusual the writer has deemed it worth while to present here the results of some work done by a class of students and himself along this line.

Colonies of *Volvox aureus* Ehrenberg were found last fall in some abundance in small sphagnum pools on the west shore of a small glacial lake west of Ann Arbor known as the First Sister Lake. Collections were made on October 27, 1915. Small water-filled depressions in the sphagnum 10 to 30 inches in diameter were